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Technical Report ARWSE-TR-14027

## **WAITING ON MORE THAN 64 HANDLES**

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**U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT AND  
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**Picatinny Arsenal, New Jersey**

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14. ABSTRACT  It's often necessary for a Windows based program to wait on a handle to a thread or some other resource during its execution. Occasionally, it's necessary for a program to wait on many handles at one time. If the number of handles exceeds MAXIMUM_WAIT_OBJECTS, which is currently defined as 64, then some extra code must be written to deal with this.					
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## INTRODUCTION

The need to wait on more than 64 handles was first encountered while upgrading some old software to run more efficiently by breaking down tasks to run in multiple worker threads. Almost 200 threads were spawned and then it was found that there was a maximum number of handles that could be waited on. The maximum was set by a global definition of `MAXIMUM_WAIT_OBJECTS`, which equals 64. All of the threads/tasks needed to be completed first in order to report the completion of the process to the calling function.

## METHODOLOGY

The initial situation presented was having all of the handles to the threads inside a `std::vector`. The general idea to handle this situation was to break down the number of thread handles into 64 or less chunks and spawn a subsequent thread for each group. That thread would then wait on the 64 thread handles of that group. Then, one would wait on all the handles produced by spawning a thread for each group.

The following sequence is the block of code/algorithm that was created for the situation of having more than 64 handles:

```
std::vector<HANDLE> new_handles;
int threads_needed = FCT_Threads.size() / MAXIMUM_WAIT_OBJECTS;
threads_needed += ((FCT_Threads.size() % MAXIMUM_WAIT_OBJECTS) == 0) ? 0 : 1;
for(int i = 0; i < threads_needed; ++i)
{
    WaitThreadData* data = new WaitThreadData;
    if((i + 1) < threads_needed)
    {
        data->quantity = MAXIMUM_WAIT_OBJECTS;
        memcpy_s(data->handles, sizeof(HANDLE) * MAXIMUM_WAIT_OBJECTS, &FCT_Threads[i * MAXIMUM_WAIT_OBJECTS],
        sizeof(HANDLE) * MAXIMUM_WAIT_OBJECTS);
    }
    else
    {
        //partial group
        data->quantity = FCT_Threads.size() % MAXIMUM_WAIT_OBJECTS;
        memcpy_s(data->handles, sizeof(HANDLE) * data->quantity, &FCT_Threads[i * MAXIMUM_WAIT_OBJECTS], sizeof(HANDLE) * data->quantity);
    }

    HANDLE ct = CreateThread(NULL, 0, CFCT_GenDlg::WaitThreads, (LPVOID)data, 0, NULL);
    new_handles.push_back(ct);
}

unsigned long ret = WaitForMultipleObjects(new_handles.size(), new_handles.data(), true, INFINITE);
```

The first step the code takes is to figure out how many threads need to spawn. This is achieved by dividing by the maximum wait objects and then checking for a remainder. If there is a remainder, then an additional thread will be needed for the partial group. The next step is to iterate once for the number of threads needed, filling the parameter struct appropriately. The parameter struct is comprised of an array of handles with a maximum size of `MAX_WAIT_OBJECTS` and an integer holding the total quantity.

Once all the “waitthreads” are created, a final wait is initiated on the current thread with the handles of all the created “waitthreads.” Upon return, all the threads would have completed running their tasks and can be cleaned up.

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## CONCLUSIONS

This code snippet is not the silver bullet for all problems associated with waiting on more than 64 handles. It will, however, work for up to 4,096 generated threads. It does give a very good starting point for anyone dealing with a similar issue.



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